



Acoustic testing at wind tunnel facilities of German-Dutch Wind Tunnels (DNW)



German-Dutch Wind Tunnels

Christophe Hermans, Deputy Director

Christophe.Hermans@dnw.aero (+31.527.248523)

Contents

- ❑ DNW organization
 - Sites & facilities
 - Customers
- ❑ DNW Large Low speed Facility LLF
 - Initial design
 - Acoustic upgrades
- ❑ Key test capabilities & measurement techniques
 - Measurement techniques
 - Test capabilities
- ❑ Conclusions



DNW sites



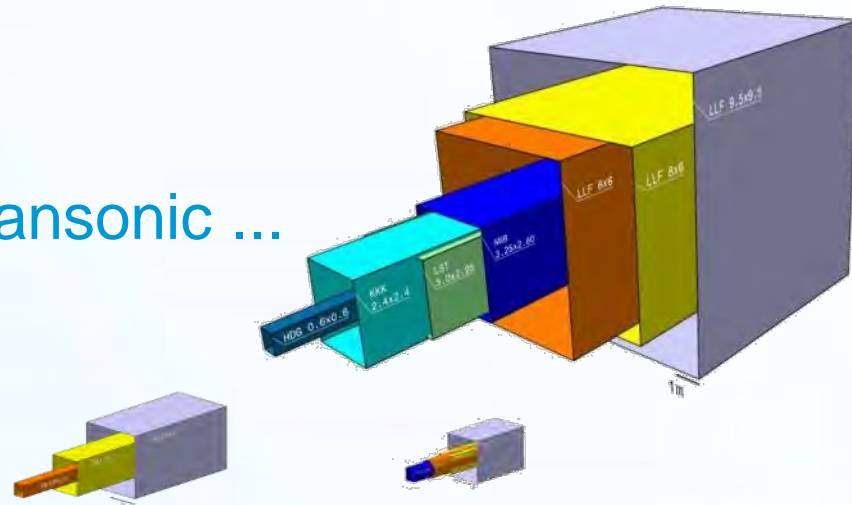
- | | |
|-----------------|-----------------|
| 1) Amsterdam | The Netherlands |
| 2) Marknesse | The Netherlands |
| 3) Braunschweig | Germany |
| 4) Göttingen | Germany |
| 5) Köln | Germany |

DNW wind tunnel facilities

Subsonic, ...



transonic ...



... and supersonic wind tunnels

- ❑ Testing for industrial customers: LLF & HST
- ❑ Non-aeronautical tests: LST
- ❑ DLR R&D wind tunnel tests: NWB, KKK, TWG, HDG, KRG, RWG

Global customer base

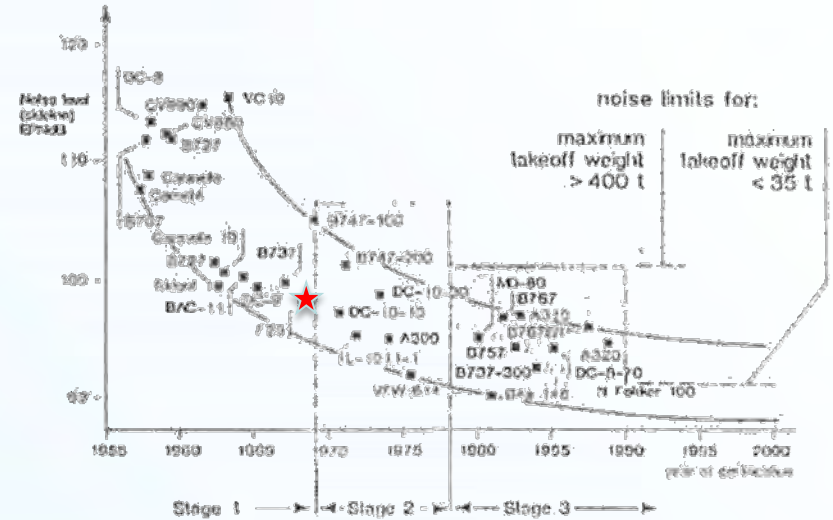


Contents

- DNW organization
 - Sites & facilities
 - Customers
- DNW Large Low speed Facility LLF
 - Initial design
 - Acoustic upgrades
- Key test capabilities & measurement techniques
 - Measurement techniques
 - Test capabilities
- Conclusions

DNW-LLF original background noise level design target

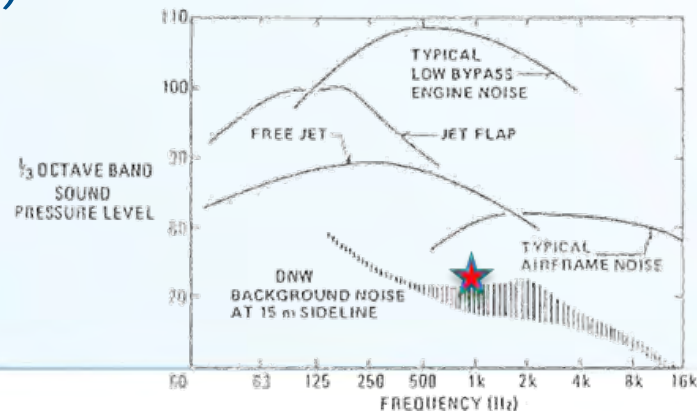
- Early 70ties initial background noise design point based on Fokker F-28 Mk 1000 (take-off side-line noise level at 500 ft)
- Aim for 95 EPNdB to account for future more stringent A/C noise requirements
- DNW-LLF design phase target set to 73 dB (1/3 octave band @ 1kHz, 80 m/s, 15 m tunnel side line)



Source: Smith, Aircraft noise, Cambridge (1989)



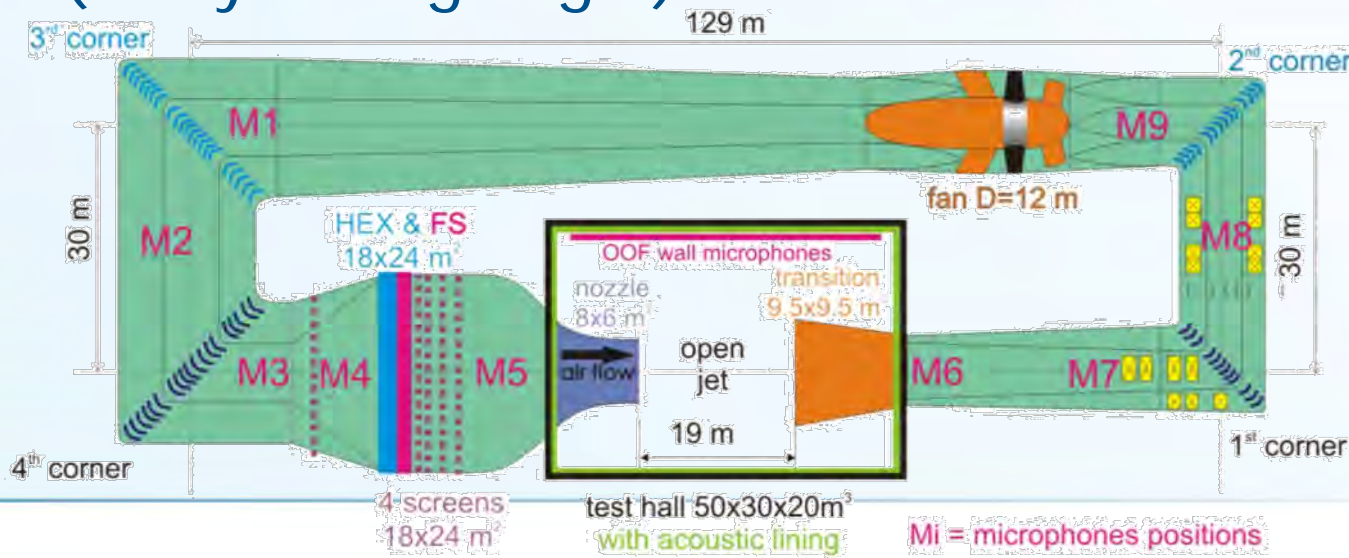
DNW BACKGROUND NOISE, WIND SPEED 80 m/s



Acoustic upgrade of LLF

Reduction of background noise:

- ❑ 2010: Modification of Nozzle and Collector (minor noise sources)
- ❑ 2011: Acoustic lining of turning corners 2 & 3 (up to 6 dB reduction)
- ❑ 2014: Upgrade of Heat Exchanger – Flow Straightener (analysis ongoing...)



Contents

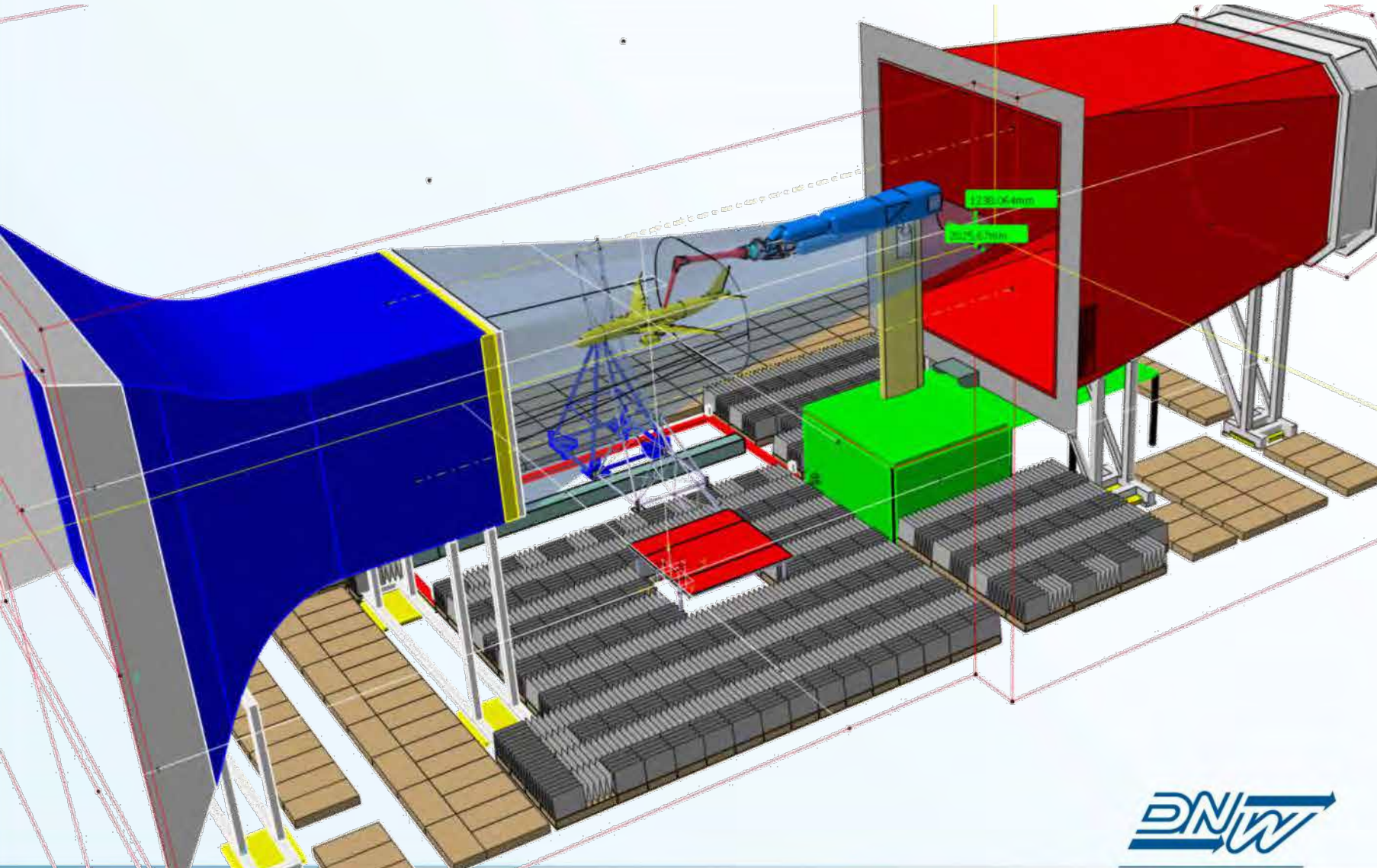
- DNW organization
 - Sites & facilities
 - Customers
- DNW Large Low speed Facility LLF
 - Initial design
 - Acoustic upgrades
- Key test capabilities & measurement techniques
 - Measurement techniques
 - Test capabilities
- Conclusions

Acoustic measurement techniques @ DNW

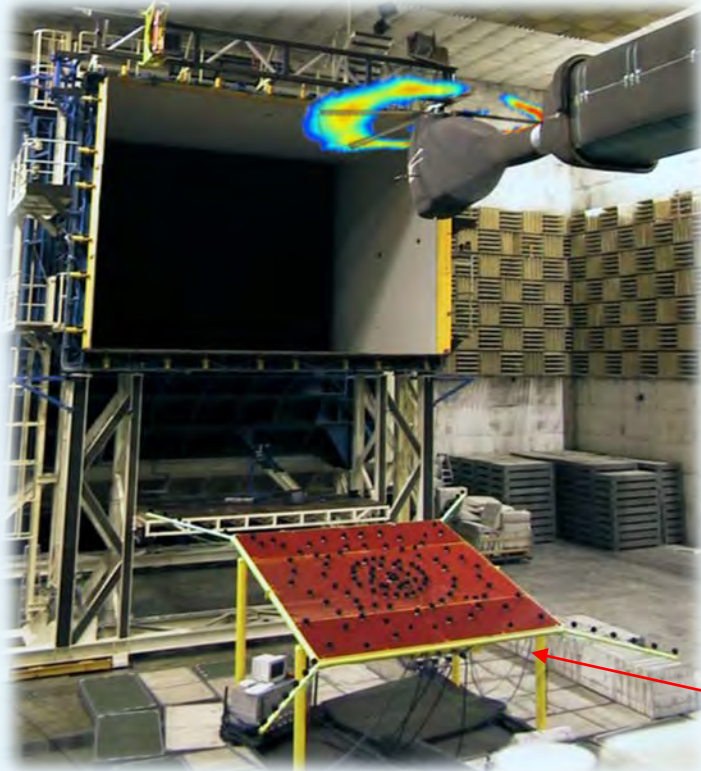
- ❑ Traversing mechanism (60 GRAS ½" free-field condenser microphone, type 40AC)
- ❑ 160 Far field microphones installed on walls, floor & ceiling (LinearX M51 type)
- ❑ 2 Out-of-flow acoustic microphone arrays (4*4m, 142 M51 free-field microphones each)
- ❑ 2 Wall installed acoustic arrays (1*1m)
- ❑ 5+4 GBM Viper systems (48 channel) data acquisition systems



Typical aircraft noise testing setup in OTS



External noise: acoustic testing



Anechoic lining
for reflection
absorption

Out-of-flow
microphone
traversing
system

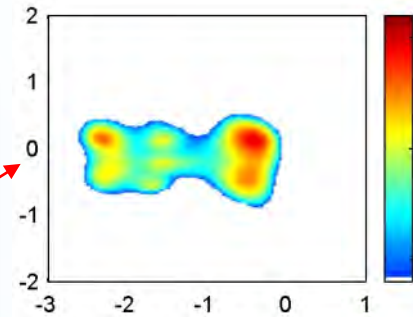
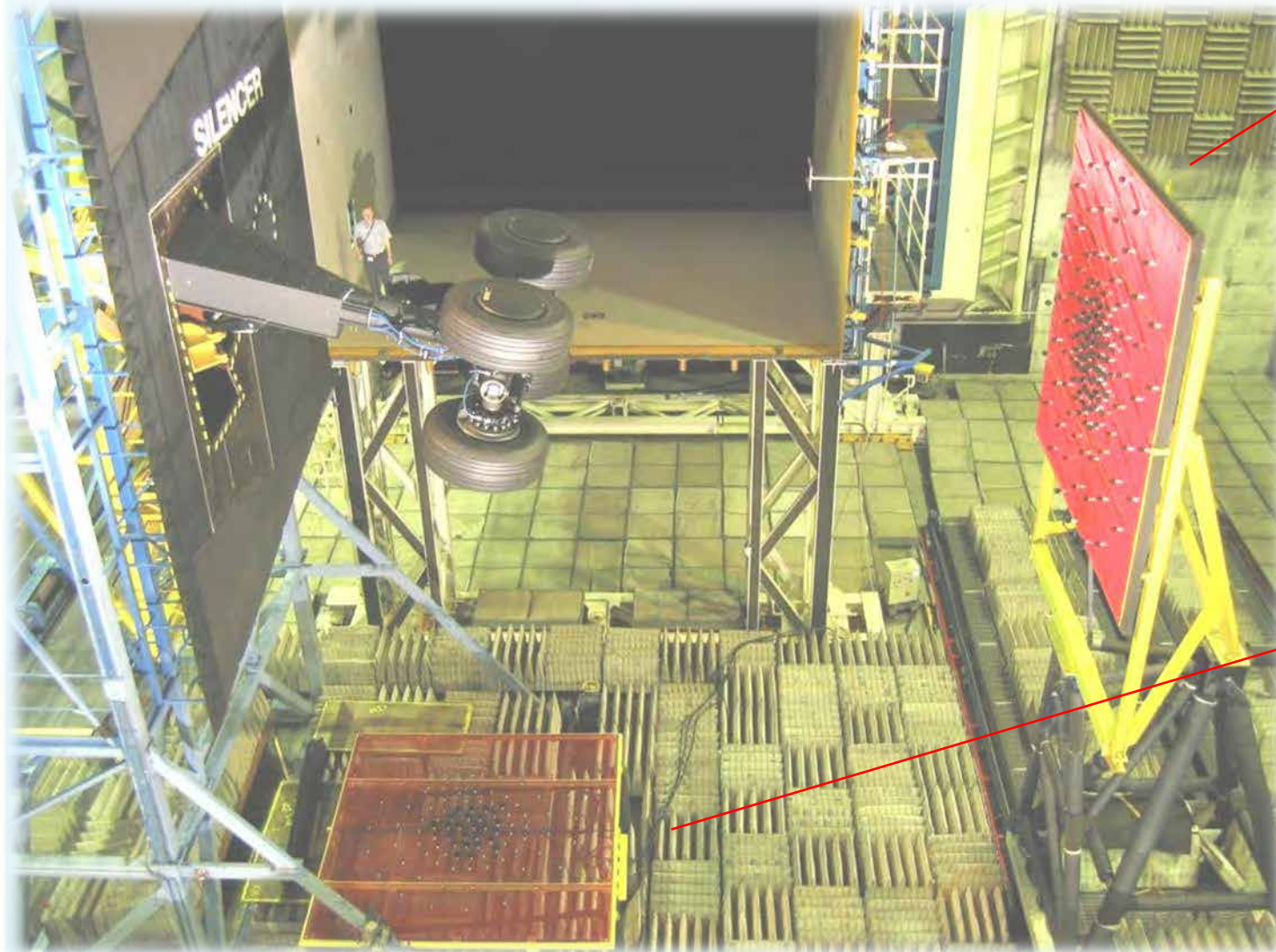
Acoustic array



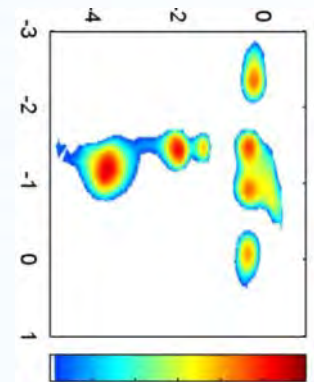
Open rotor (noise) testing



Full-scale A340 main landing gear



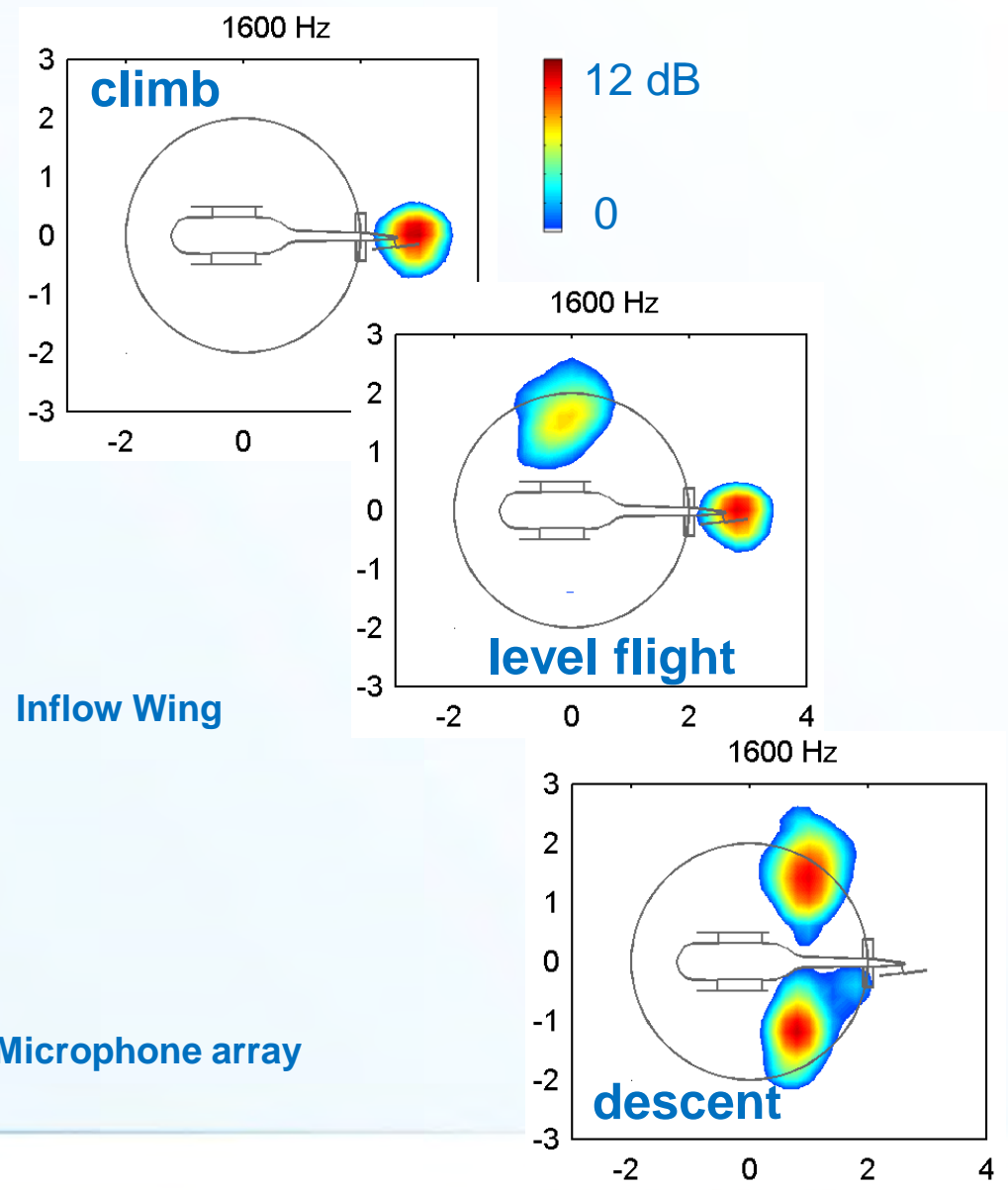
Fly-over-line-view array



Sideline-view array



Helicopter model with main- & tail rotor

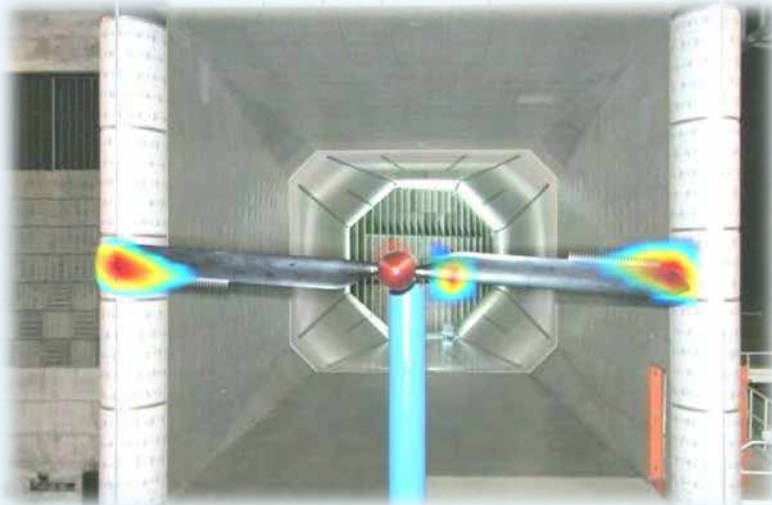
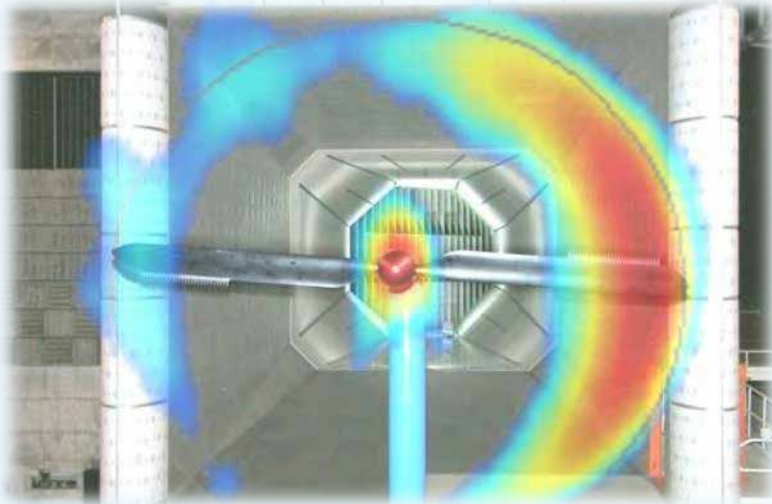


Inflow Wing

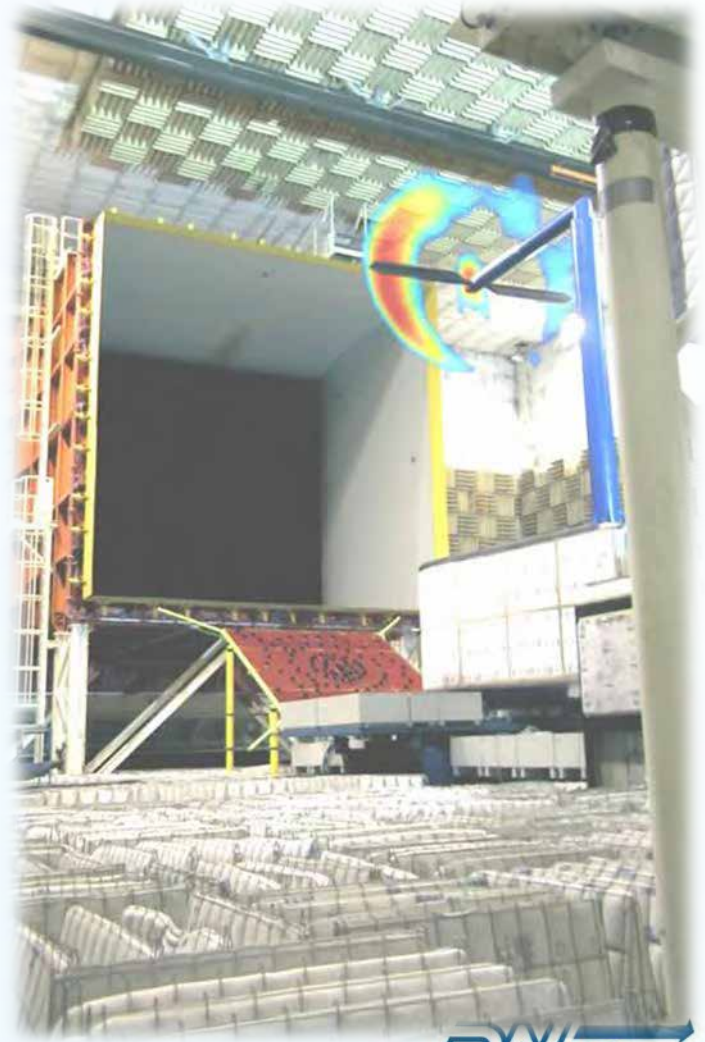
Microphone array

Wind turbine in DNW-LLF

Noise sources identification
in rotor plane



noise



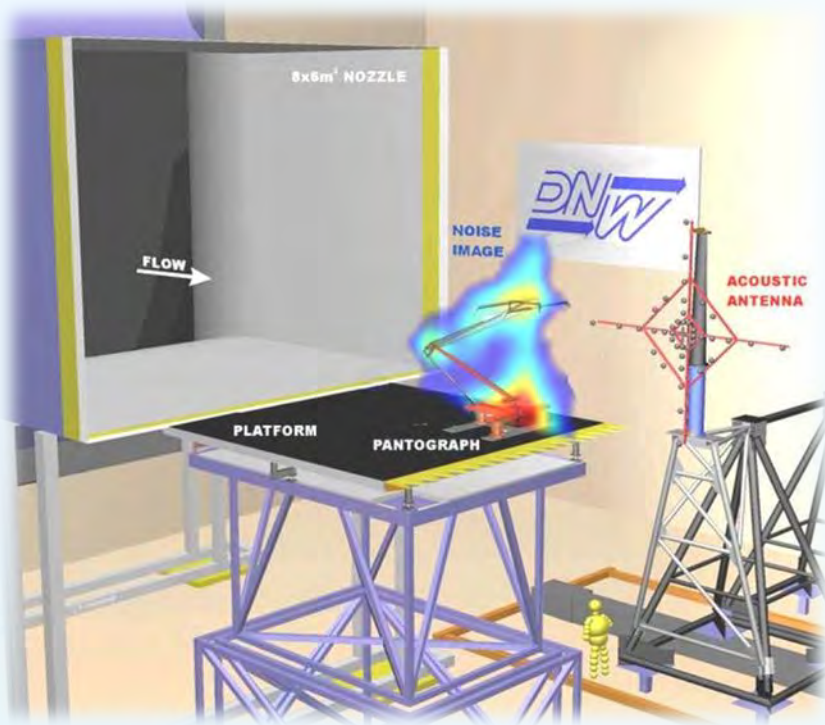
Noise sources identification
for individual rotor blades

Wall array and A340 1:10 model



0.5x0.5 m²
Wall Array

Various



Contents

- DNW organization
 - Sites & facilities
 - Customers
- DNW Large Low speed Facility LLF
 - Initial design
 - Acoustic upgrades
- Key test capabilities & measurement techniques
 - Measurement techniques
 - Test capabilities
- Conclusions

Conclusions

- ❑ DNW facilities are used extensively for aircraft testing by European and non-EU industries
- ❑ Versatile technologies as part of wind tunnel infrastructure, with focus on aircraft noise (engine integration & ground effect)
- ❑ Additional strength through availability of technology and analysis capabilities from parent institutes DLR and NLR

